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Eight new records of lichenized and lichenicolous fungi from Turkey

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Abstract—From Akdağ, Aegean Region, Turkey, four lichenized fungi (*Circinaria elmorei*, *Gyalidea fritzei*, *Placynthium lismorense*, *Rhizocarpon atroflavescens* subsp. *pulverulentum*), three lichenicolous lichens (*Buellia uberior*, *Endohyalina brandii*, *Rhizocarpon vorax*), and one lichenicolous fungus (*Phaeospora parasitica*) are reported for the first time from Turkey. Comments on their habitats, substrata, and key anatomical features and photographs are provided for each species.

Key words—*Ascomycota*, Afyon, Denizli, biodiversity

Introduction

Lichenized and lichenicolous fungal biota of Turkey are much better known than compared with 20 years ago. Now approximately 1300 species of lichenized fungi (Halıcı 2015, Kocakaya & Halıcı 2015, Yavuz et al. 2015) and 200 species of lichenicolous fungi (Halıcı 2008, Halıcı et al. 2013, Kocakaya et al. 2015) are known from the country. Nonetheless, this number should be higher, as there are many areas in Turkey that have never been explored lichenologically (Halıcı et al. 2007).

All new records given in this paper were collected in Akdağ, within the Afyon and Denizli city borders in the Aegean area of Turkey. Previously, one lichenicolous fungus, *Stigmidium humidum* Pérez-Ortega et al., was described from Afyon Province and two, *Llimoniella muralicola* Halıcı and *Phoma recepii* Halıcı & Candan, from Denizli Province (Halıcı 2008,

Halıcı et al. 2014, Pérez-Ortega et al. 2010). Despite floristic studies carried out in the provinces of Afyon (Çobanoğlu & Yavuz 2006, Kınalıoğlu & Aptroot 2012) and Denizli (Şenkardeşler & Sukatar 2006, Yavuz & Çobanoğlu 2007), the lichen floras of these provinces are far from complete. Here we add information on eight lichenized and lichenicolous fungi collected from Akdağ (Afyon, Denizli), all of which represent new records for Turkey.

Material & methods

The specimens are deposited in the Anadolu University Herbarium, Eskişehir, Turkey (ANES). They were examined by standard microscopic techniques using a Leica MZ6 model stereo microscope and a Zeiss Axio Imager A2 model light microscope. The macro photographs were taken with a Leica DFC 320 and a Panasonic Lumix DCM-TZ10. Hand-cut sections were studied mostly in water, but if necessary potassium hydroxide (KOH) and Lugol's solution (I) were also used. Measurements were taken in water. Ascospores were measured from five different ascoma for each species; the data are given as minimum–maximum from N measurements. The descriptions below are based on the Turkish specimens.

Taxonomy

Buellia uberior (Nyl.) Anzi, Atti Soc. Ital. Sci. Nat. 9: 252. 1888. Fig. 1

A facultative lichenicolous lichen on a *Schaereria fuscocinerea* thallus. Thallus shiny, grayish to pale gray with a prothallus. Apothecia black, shiny, lecideine, superficial, mostly on the edges of the areoles. Epihymenium greenish, hymenium 45–60 µm tall. Medulla C+ red (gyrophoric acid), K+ yellow, I+ violet. Ascospores of the *Buellia*-type, brown, with striate ornamented walls, 9–12 × 5–7 µm (N = 20).

Specimen examined: **TURKEY**, **Denizli**, **Çivril,** Akdağ, northwestern slopes of Akdağ, *Pinus nigra* forest, 38°24′09″N 29°59′12″E, alt. 1375–1400 m, parasitic on the thallus of *Schaereria fuscocinerea* on siliceous rocks, 9 June 2008, M. Candan (ANES 14769).

The Turkish specimen collected on *Schaereria fuscocinerea* is parasitic on the host thallus, eventually destroying it. The host was found on the north faces of siliceous rocks with lichens such as *Rhizocarpon geographicum*, *Lecanora sulphurea*, and *Tephromela atra*.

The Turkish specimen agrees with the descriptions of Scheidegger (1987, 1993). The other lichenicolous *Buellia* species growing on *Schaereria* spp. is *B. miriquidica* Scheid., differing in its psilate ascospore walls and chemistry (miriquidic acid; Scheidegger 1987, 1993).

Circinaria elmorei (E.D. Rudolph) Owe-Larss., A.Nordin & M.Sohrabi, Biblioth. Lichenol. 106: 244. 2011. Fig. 2

Thallus more or less verrucose; c. 2 cm diam. and c. 1–1.5 mm thick; areoles more or less convex. Apothecia aspicilioid, abundant and almost totally covering the entire thallus surface, 0.5–1.5 mm diam., round to elongated; disc usually black, but appearing bluish because of the white pruina; thalline margin very thick, darker than the thallus, almost black. Epihymenium olive brown; hymenium hyaline, I+ blue; 150–170 µm tall. Asci clavate; 4-spored. Ascospores hyaline, simple, globose to subglobose, 20–26(–30) × 20–23 µm (N = 30). Pycnidia not observed.

Specimens examined: **TURKEY**, **Afyon**, **Sandıklı**, Akdağ, west of Reşadiye Village, steppe, 38°24′58″N 30°09′51″E, on small calcareous rocks near ground, alt. 1120 m, 8 June 2008, M. Candan (ANES 18606); **Kızılören**, Akdağ, west of Kızılören, calcareous rocks, *Quercus* sp. communities, 38°14′50″N 30°08′10″E, alt. 1166 m, on small calcareous rocks near ground, 28 September 2007, M. Candan (ANES 14636); **Dinar**, east of Cerityaylası Village, 38°21′20″N 30°06′54″E, alt. 1510 m, on calcareous rocks, 4 June 2008, M. Candan (ANES 18670); northwest of Karakuyu Village, 38°05′22″N 30°11′06″E, alt. 1040 m, calcareous rocks, 8 June 2008, M. Candan (ANES 17215); **Denizli, Çivril**, Akdağ, Kurucova Hill, 38°20′26″N 29°57′33″E, alt. 1881 m, on small calcareous rocks near ground, 5 June 2008, M. Candan (ANES 18471).

The Turkish specimens agree with the description of Owe-Larsson et al. (2011). *Circinaria elmorei* is first described in 1953 in New Mexico, USA by R.D. Rudolph based on *Lecanora elmorei*. *Circinaria elmorei* (saxicolous and non-vagrant) is morphologically similar to the European *Aspicilia desertorum* (Kremp.) Mereschk. which is illegitimate name since it represents more than one taxon (Owe-Larsson et al. 2011). Within this study, *Circinaria elmorei,* which was collected on the calcareous rocks and small stones, represents the first record from Turkey under this name.

Endohyalina brandii Giralt, van den Boom & Elix, Mycol. Progr. 9(1): 41. 2010. Fig. 3

A lichenicolous lichen on the thallus of *Aspicilia intermutans*. Thallus absent (endokapylic). Apothecia common, lecideine, black, adnate to sessile, 0.1–0.2 mm diam., mostly on the edges of the host thallus areoles or apothecia. Epihymenium brown to dark brown, hymenium hyaline but sometimes with a slight olive tinge, hypothecium brown to reddish brown. Ascospores brown, *Dirinaria*-type when young but *Physconia*-type when mature, 12–16(–19) × 6–9(–10) µm (N = 20). Pycnidia not observed.

Specimen examined: **TURKEY**, **Afyon**, **Sandıklı,** Akdağ, Başalan Plateau, location of Derealanı, *Pinus nigra* forest, 38°19′03″N 30°02′09″E, alt. 1453 m, on the thallus of *Aspicilia intermutans*, 3 June 2008, M. Candan (ANES 18367).

This obligately lichenicolous lichen species was described on *Aspicilia intermutans* and is previously known only from the Canary Islands and the Iberian Peninsula (Giralt et al. 2010, Nadyeina et al. 2010). This new record from Turkey extends the known distribution of *Endohyalina brandii,* which should be searched for elsewhere on *Aspicilia* spp. growing on siliceous rocks. The Turkish specimen has no visible thallus and produces longer and broader ascospores than originally described by Giralt et al. (2010).

Gyalidea fritzei (Stein) Vězda, Folia Geobot. Phytotax. 1: 324. 1966. Fig. 4

Thallus rimose-areolate, slightly rusty red to yellowish. Apothecia common, emergent but immersed when young, sessile, sometimes grouped (2–3 apothecia together), disc concave, disc and margin dark brown to blackish, although the margin is usually pruinose. Asci 8-spored, dextrinoid, 70–100 × 20–25 µm (N = 10). Ascospores slightly constricted in the middle, muriform, olivaceous green, 17–23 × 12.5–15 µm (N = 10). Gelatinous sheath distinct, nearly 3 µm thick. Conidia 3–5 × 1 µm (N = 10).

Specimen examined: **TURKEY**, **Afyon**, **Sandıklı**, Akdağ, Başalan Plateau, location of Derealanı, *Pinus nigra* forest, 38°19′03″N 30°02′09″E, alt. 1453 m, on siliceous rocks in shaded situation, 3 June 2008, M. Candan (ANES 18731).

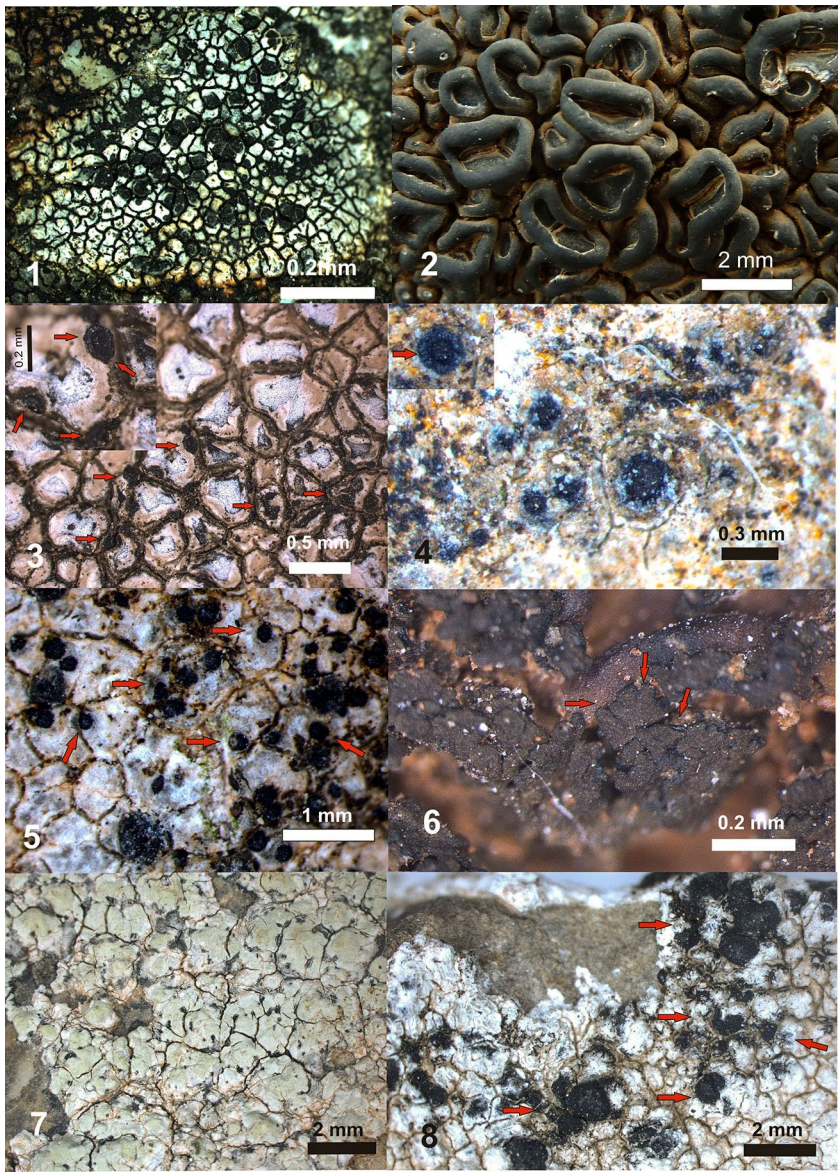
The Turkish specimen was collected on siliceous rocks near a stream in a shady and relatively humid habitat; it agrees with the description of Vězda (1966) and Wirth et al. (2013). *Gyalidea fritzei* is known from Europe (Vězda 1966, Orange 1990) and North America (Hutten et al. 2013). New to Asia.

Phaeospora parasitica (Lönnr.) Arnold, Flora 57: 151. 1874. Fig. 5

Lichenicolous fungus on *Rhizocarpon umbilicatum*. Ascomata perithecia, black, immersed to sessile on the host areoles, mostly arising singly, 0.1–0.2 mm diam. Asci 8-spored. Ascospores hyaline when young but brown when mature, mostly 3-septate, the over-mature ascospores have constricted walls near the septa, 17–20 × 6–8 µm (N = 10).

Specimen examined: **TURKEY**, **Afyon**, **Sandıklı,** Akdağ, Başalan Plateau, location of Derealanı, *Pinus nigra* forest, 38°19′03″N 30°02′09″E, alt. 1453 m, on the thallus of *Rhizocarpon umbilicatum* on siliceous rocks, 3 June 2008, M. Candan (ANES 18730).

The Turkish specimen was collected on the areoles of *Rhizocarpon umbilicatum* on siliceous rocks; it agrees with the descriptions of Vězda (1963) and Alstrup & Hawksworth (1990). In the infected areoles of the host lichen distinct bleaching



Figs 1–8. **1**. *Buellia uberior* on the thallus of *Schaereria fuscocinerea*; **2**. *Circinaria elmorei*; **3**. *Endohyalina brandii* (arrow) on the thallus of *Aspicilia intermutans*; **4**. *Gyalidea fritzei*, apothecium (arrow); **5**. *Phaeospora parasitica* (arrow) on the thallus of *Rhizocarpon umbilicatum*; **6**. *Placynthium lismorense* (arrow); **7**. *Rhizocarpon atroflavescens* subsp. *pulverulentum*; **8**. *Rhizocarpon vorax* (arrow) on *Pertusaria* sp.

was observed. *Phaeospora parasitica* is a common parasitic lichenicolous fungus on *Rhizocarpon* spp., especially in northern Europe (Ihlen & Wedin 2008, Alstrup & Hawksworth 1990). Alstrup & Hawksworth (1990) reported this fungus from Greenland on various crustose lichens but the specimens reported on hosts other than *R. umbilicatum* should be re-examined (Sérusiaux et al. 1999).

Placynthium lismorense (Cromb.) Vain., Ark. Bot. 8(4): 98. 1909. Fig. 6

Thallus dark brown to black, with well-developed lobes at the margin, ≤10 mm diam., prothallus not visible. Apothecia rare, c. 0.5 mm diam., blackish with a distinct thalline margin. Ascospores 1-septate, hyaline, usually slightly curved, 11–16 × 5–6 µm (N = 10). Pycnidia not observed.

Specimens examined: **TURKEY**, **Afyon**, **Sandıklı**, Akdağ, Başalan Plateau, location of Derealanı, *Pinus nigra* forest, 38°19′03″N 30°02′09″E, alt. 1453 m, on calcareous soil, 3 June 2008, M. Candan (ANES 19060); **Kızılören,** Akdağ, west of Gülyazı Village, 38°14′29″N 30°05′54″E, alt. 1300 m, on calcareous soil, 28 November 2007, M. Candan (ANES 17454).

This cyanolichen is known from Europe (Köfaragó-Gyelnik 1940, Czeika & Czeika 2007, Carballal & Paz-Bermúdez 2008). The Turkish specimens were collected on hard soil in the crevices of calcareous rocks with *Catapyrenium squamulosum*; they agree with the descriptions of *Placythium lismorense* by Czeika & Czeika (2007) and Smith et al. (2009).

Rhizocarpon atroflavescens* subsp. *pulverulentum (Schaer.) Runemark, Opera Bot. 2(1): 132. 1956. Fig. 7

Thallus areolate, very pale yellowish, and mostly strongly pruinose. Prothallus whitish, blue-green and thick. Apothecia mostly in the margin of the areoles, mostly immersed, black. Epihymenium reddish, K+ red. Asci 8-spored. Ascospores muriform, greenish when young, dark brown when mature, 23–36 × 13–20 µm (N = 20).

Specimen examined: **TURKEY**, **Afyon**, **Kızılören,** Akdağ, west of Kızılören, *Quercus* sp. communities, 38°14′50″N 30°08′10″E, alt. 1166 m, on slightly calcareous rocks, 28 November 2007, M. Candan (ANES 14716).

Rhizocarpon atroflavescens is easily distinguished from other yellow *Rhizocarpon* species by its whitish and irregularly subdivided areolae and relatively small and sparsely septate ascospores (Runemark 1956, Wirth et al. 2013). There are two subspecies: *R. atroflavescens* subsp. *pulverulentum* differs from *R. atroflavescens* Lynge subsp. *atroflavescens* by having a thicker thallus and Pd+ areolae (Runemark 1956). *Rhizocarpon atroflavescens* subsp.

pulverulentum is known from the Alps, the Pyrenees and the Scandinavian Mountains (Runemark 1956, Llimona 1976). The Turkish specimen agrees with the descriptions of Runemark (1956) and Wirth et al. (2013) and represents a new record for Asia.

Rhizocarpon vorax Poelt & Hafellner, Herzogia 6(1–2): 311. 1983. Fig. 8

A lichenicolous lichen on the thallus of *Pertusaria* sp. Thallus completely immersed in the host lichen and hardly visible. Apothecia black, without margin, rounded, 0.1–0.2 mm diam. Asci 8-spored, 100–110 × 30–40 µm (N = 10). Ascospores greenish when young (later brown), muriform, mostly 4–6-celled, 26–36 × 15–22 µm (N = 20).

Specimen examined: **TURKEY**, **Afyon**, **Sandıklı**, Akdağ, Başalan Plateau, location of Derealanı, *Pinus nigra* forest, 38°19′03″N 30°02′09″E, alt. 1453 m, on the thallus of *Pertusaria* sp. on siliceous rocks, 3 June 2008, M. Candan (ANES 17460).

Rhizocarpon vorax was found as a parasitic and obligate lichenicolous lichen on *Pertusaria* sp. on siliceous rocks in more or less humid habitat in Turkey. The Turkish specimen agrees with the description of Poelt & Hafellner (1982) and represents a new record for Asia.

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